DTU Library

In Operando Raman spectroscopy for investigation of solid oxide electrolysis cells

Traulsen, Marie Lund; Walker, R. A.; Holtappels, Peter

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Traulsen, M. L., Walker, R. A., & Holtappels, P. (2017). *In Operando Raman spectroscopy for investigation of solid oxide electrolysis cells*. Poster session presented at International Conference on Electrolysis, Copenhagen, Denmark.

In Operando Raman spectroscopy for investigation of solid oxide electrolysis cells

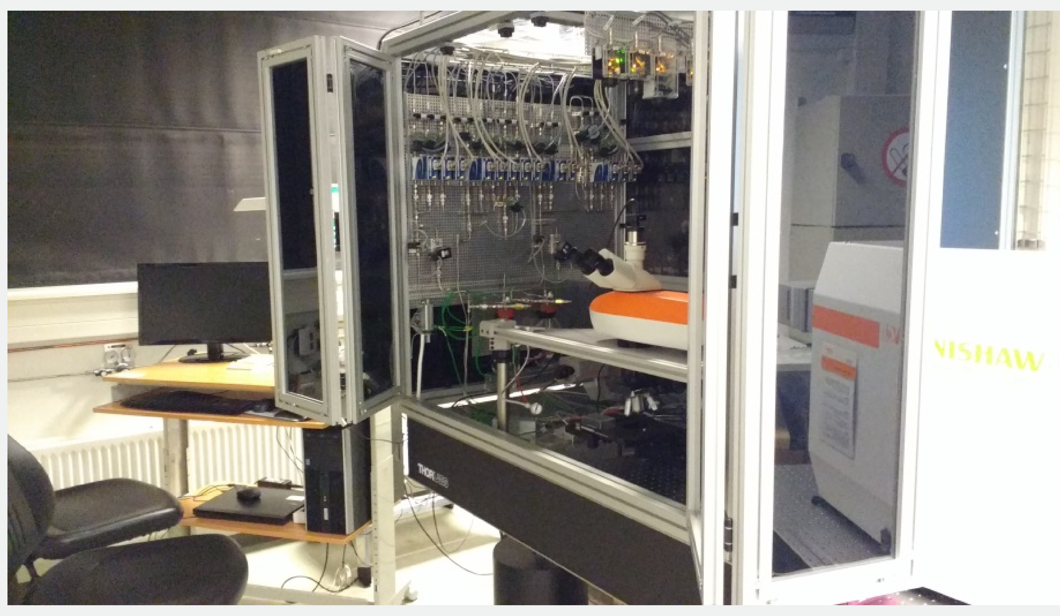
Marie Lund Traulsen[a], R. A. Walker[b], Peter Holtappels[a]

[a]Technical University of Denmark, DTU Energy; [b] Montana State University, Department of Chemistry and Biochemistry

Raman spectroscopy is an optical, vibrational spectroscopy well suited for in operando investigations, as the technique can be applied at the temperatures and gas pressures used during operation of solid oxide eletrolysis cells.

For this reason DTU Energy has invested in a Raman lab dedicated to in operando investigation of solid oxide electrolysis cells - and other electrochemical systems.

Figure 1.The Raman lab facility at DTU Energy



Available in the Raman lab:

- Renishaw inVia Raman spectrometer
- 3 lasers: 785 nm (NIR), 532 nm (VIS), 325 nm (NUV)
- A wide range of gasses: O_2, Ar, N_2, CO_2, CO, CH_4, H_2, 9% H_2 in N_2, 1% Propen (C_3H_6) in Ar,1% NO in Ar, 200 ppm H_2S in H_2
- Different testhouses/teststations…

In operando monitoring of carbon depositions in a Ni-YSZ cell

The carbon depostion in 50% CO/50% CO_2 at 750 °C was followed on a symmetric Ni-YSZ cell mounted vertically in the test-house to allow for monitoring of the electrochemiacally active region.

Figure 2. The mounting of the Ni-YSZ symmetric cell in the Linkam stage

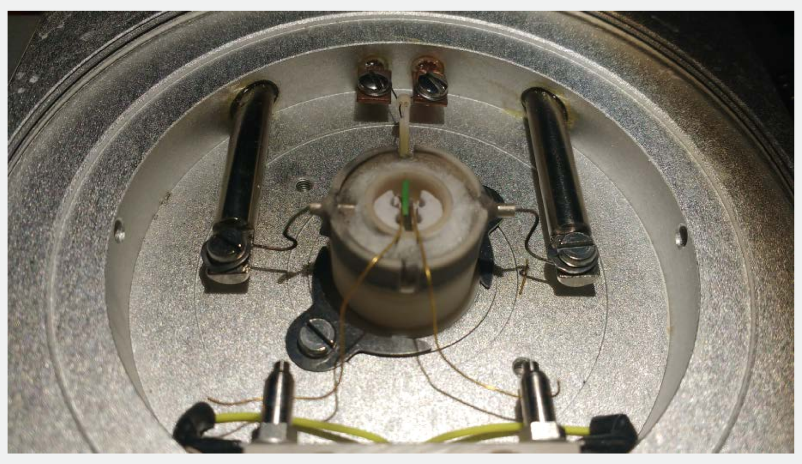


Figure 3. Optical microscopy image of the cell cross-section

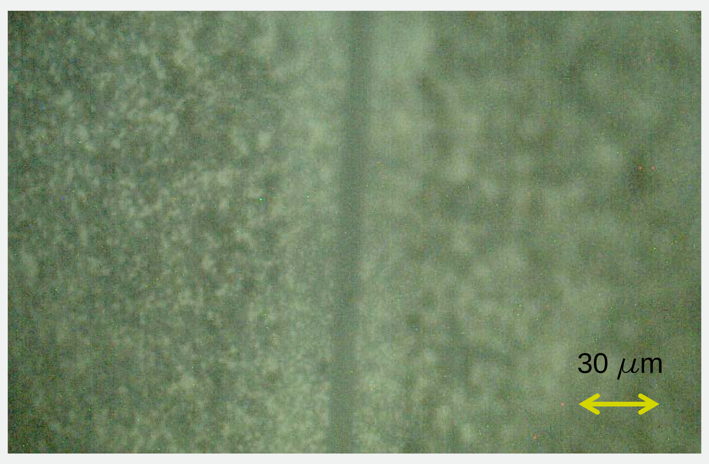


Figure 4. Raman spectrum recorded at 750 °C in humidified hydrogen

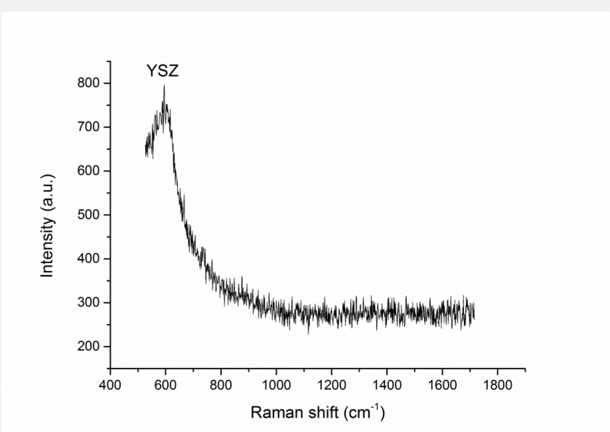


Figure 5. Raman spectrum recorded at 750 °C 50% CO /50% CO_2 mixture

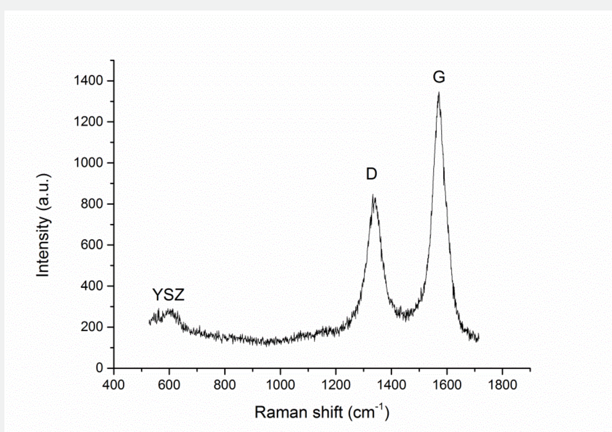
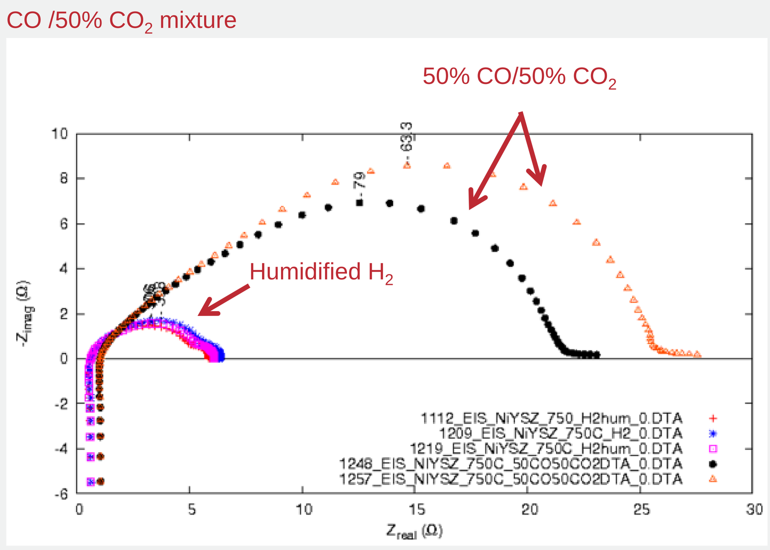


Figure 6. EIS recorded at 750 °C in humidified hydrogen and 50% CO /50% CO_2 mixture



Reversible Decomposition of Secondary Phases in BaO Infiltrated LSM Electrodes—Polarization Effects

Compositional changes in BaO-modified lanthanum strontium manganite (LSM) electrodes where observed during electrical polarization. The applied cathodic potential resulted in a reversible decomposition of a secondary $Ba_3Mn_2O_8$ phase

Figure 7. Top-view of LSM thin film electrode surface with Au current collectors

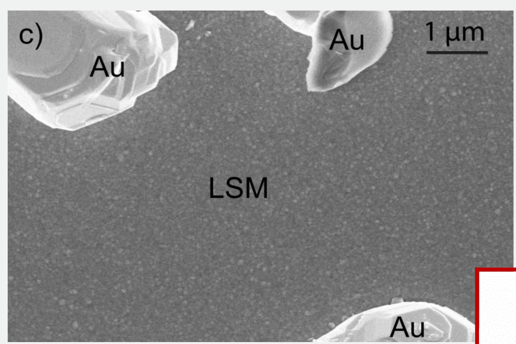


Figure 8. Top-view of LSM thin film electrode surface with Au current collectors and with BaO deposition

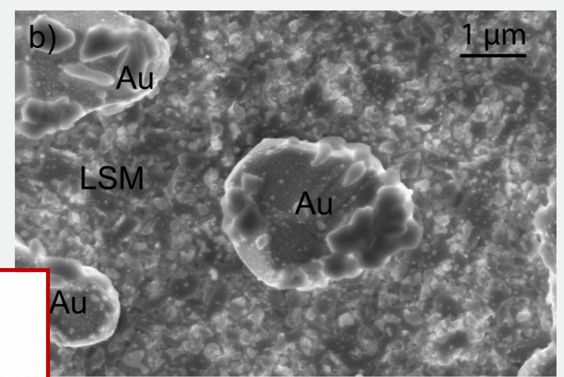
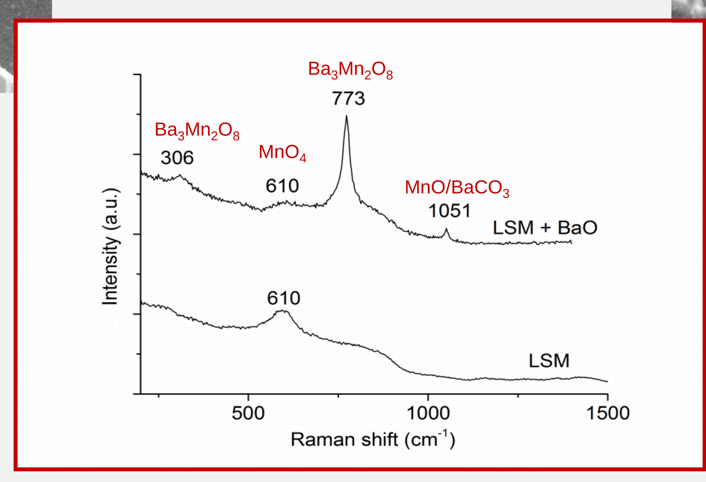


Figure 9. Raman spectra recorded on a LSM thin film electrode without and with BaO modification



Raman shift [cm^{-1}]	Assignment
306	$Ba_3Mn_2O_8$
610	MnO_4
644	Mn_3O_4
773	$Ba_3Mn_2O_8$
1051	$MnO/BaCO_3$

Figure 10. Onset of -1V cathodic polarization

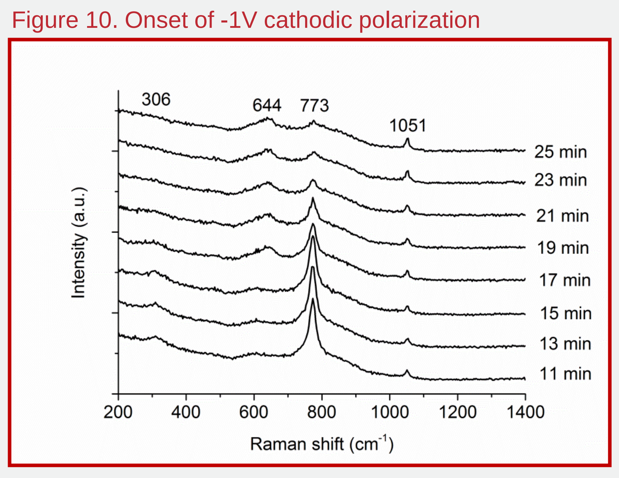


Figure 11. Returning to OCV after -1V cathodic polarization

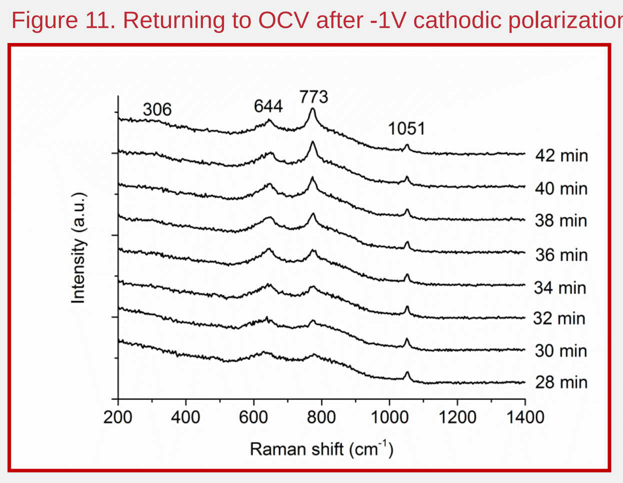
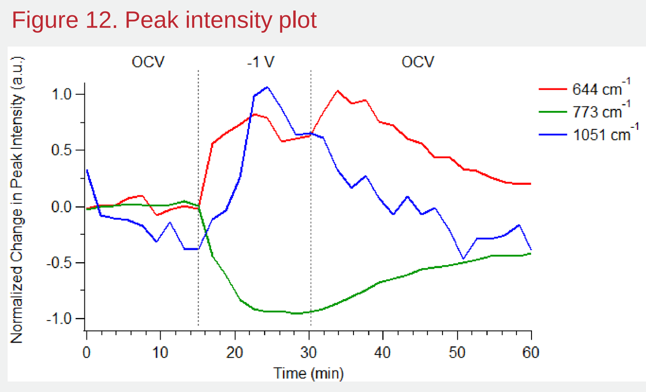


Figure 12. Peak intensity plot



Results published by
M. L. Traulsen, M.D. McIntyre,K. Norrman, S. Sanna,M. B. Mogensen, and R. A. Walker *Adv. Mater. Interfaces* **2016**, 1600750

For further information please contact Marie Lund Traulsen (matr@dtu.dk)